Brief Communication Communication brève

Assessing fitness in endurance horses

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Abstract — A field test and a standardized treadmill test were used to assess fitness in endurance horses. These tests discriminated horses of different race levels: horses participating in races of 120 km and more showed higher values of VLA4 (velocity at which blood lactate reached 4 mmol/L) and V200 (velocity at which heart rates reached 200 beats per min) than horses of lower race levels.

Résumé — Évaluation de la condition physique des chevaux d'endurance. Un test sur le terrain et un test sur tapis roulant ont été utilisés pour évaluer la condition physique des chevaux d'endurance. Ces tests ont séparé les chevaux de différents niveaux de course : les chevaux participant à des courses de 120 km et plus ont montré des valeurs supérieures de VLA4 (la vélocité à laquelle le lactate sanguin atteignait 4 mmol/L) et de V200 (la vélocité auxquelles les fréquences cardiaques atteignaient 200 battements par minute) que les chevaux de course de niveaux inférieurs.

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Most trainers of sport horses rely on empirical training regimens to determine the most beneficial way to condition a horse for a specific event. Assessment of fitness often depends on subjective evaluation by the trainer and/or the rider. Several fitness test protocols, either on a treadmill or on a race track have been published, but most of them are adapted to standardbred and thoroughbred horses (1–3). Taking into account the paramount importance of adequate training to reach performance in endurance horses, the lack of fitness test protocols for this type of horse (and for sport horses in general) is surprising. Endurance racing is one of the most challenging competitions of equestrian disciplines, and is becoming more demanding in terms of speed, inducing an increase in the metabolic, musculoskeletal, and cardiovascular work. Besides, owners of endurance horses are often reluctant to test their horse on a treadmill and believe that treadmill tests do not correlate well with the work usually performed in training or competition.

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The aims of this study, therefore, were: 1) to assess the ability of a field exercise test (FT), designed in agreement with the riders of endurance horses, to discriminate between different racing levels, and 2) to compare the results with those obtained in a 3-step treadmill test (TT).

After thorough clinical examinations and blood analyses, 17 healthy horses were recruited from a cohort of 50 endurance horses. These horses were presented by their owners on a voluntary basis; they were all in full training, ready to compete and did not exhibit loss of performance or recent clinical problems. The horses were divided into 2 groups based on their "racing level" during the year preceding the examination. Group A consisted of 10 horses participating successfully in races from 60 to 90 km, aged 8.8 ± 1.9 y, weighing 422.6 ± 39.7 kg (6 geldings and 4 females). These horses had participated in races for 3.3 ± 1.3 years, and had completed a mean total distance (during all races) of 863 ± 470 km. Group B consisted of 7 horses participating successfully in races of 120 km and more, aged 10 ± 1.9 y, weighing 422.7 ± 66.7 kg (2 stallions, 2 geldings, and 3 females). These horses had participated in races for 3.6 ± 1.2 y, and had completed a mean total distance (during all races) of 1619 ± 642 km.

Each horse performed 2 stepwise standardized exercise tests (SETs) on 1) a 2200 m flat sand race track, and 2) a high-speed treadmill (Mustang; Graber AG, Fahrwangen, Switzerland). The FT consisted of a warm-up phase at walk and trot followed by 3 steps: the first step consisted of a canter over 27 km at 6 m/s, the second and third steps were run over 1500 m at 7.5 m/s and 8.8 m/s, respectively. A GPS (Forerunner 205/305; Garmin, Romsey, Hampshire, UK) was used to measure velocity and completed distance. A recovery period at a slow-trot over 700 m was allowed between each step and a recovery phase at walk for 10 min ended the test.

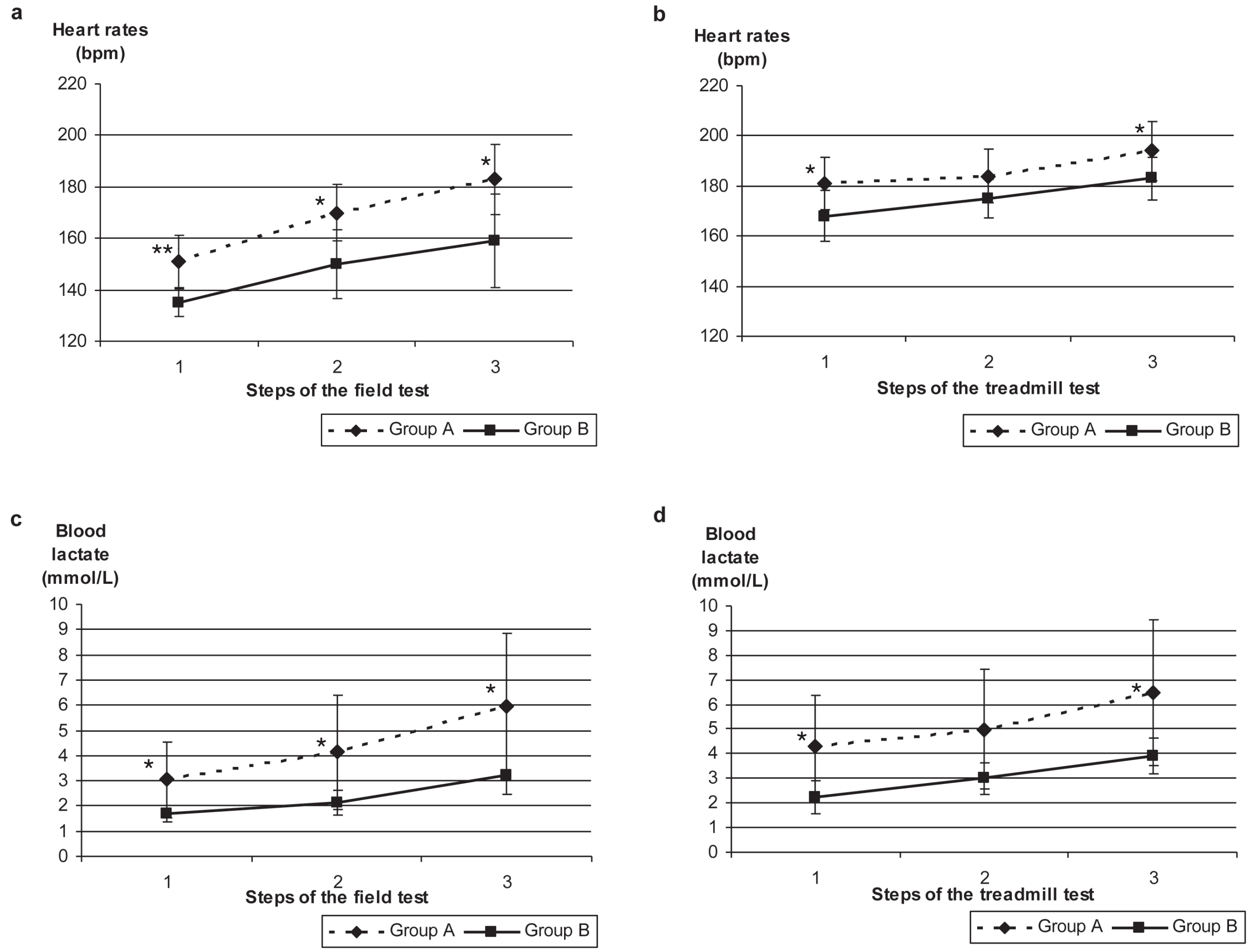

Figure 1. Physiological response to exercise (mean ± standard deviation) in 10 mid-level (60–90 km) (group A) and 7 high-level (120 km and more) (group B) endurance horses.
Heart rates achieved at each step during the field test (a) and the treadmill test (b); blood lactate evaluated at the end of each step during the field test (c) and the treadmill test (d).
* Significantly different from group B with $P < 0.05$; ** with $P < 0.01$.

For the TT, all animals were acclimated to the treadmill 4 h before attempting the test. A 5-minute warm-up at walk was followed by 5 min at trot; then the slope was set at a 4% incline, and 3 steps of 3 min each were performed at speeds of 7.5, 8.2, and 9.0 m/s, respectively. Between each step, the horses recovered at 3.5 m/s for 2 min. The horses then stepped out of the treadmill and recovered during 10 min at a walk. A base-apex ECG and the heart rate (HR) were recorded during each exercise test using a telemetry ECG system (Televet 100; Jørgen Kruuse, Marslev, Denmark). Heart rates (HRs) were recorded at walk during recovery 2, 5, and 10 min post-exercise.

Blood samples were drawn from the jugular vein at the end of each step and total blood lactate concentration was measured immediately on a portable analyzer (Accutrend Lactate; Roche, Mannheim, Germany).

Six parameters were derived from the data: namely, the velocities at which blood lactate reached 2 and 4 mmol/L (VLA2 and VLA4, respectively), which were calculated by regression analysis (blood lactate versus speed exponential curve) (2,4); the velocities at which HRs reached 160 and 200 beats per minute (bpm) (V160 and V200), which were calculated by the linear regression of HR on speed (5); and the HRs corresponding to VLA2 and VLA4 (HR2 and HR4).

Blood samples were collected on each horse at rest (prior to exercise) and 1 h after both SETs to assess hemoconcentration, dehydration, loss of electrolytes, and muscle enzyme activities.

All results were expressed as mean ± standard deviation. The calculated and obtained variables for each exercise test were analyzed using an analysis of variance (ANOVA) considering the effect of group of horses. The level of statistical significance was set at $P < 0.05$.

Ambient temperature ranged between 9°C and 18°C during the FT. The weather was cloudy but dry. During the TT, room temperature ranged between 14°C and 19°C. There was no significant difference between groups for creatine kinase (CK), electrolytes, total protein (TP), packed cell volume (PCV), erythrocyte and leucocyte counts at rest (all measurements were within normal range) and 1 h after the SETs.

Speeds during the FT were similar in the 2 groups. Values of HR and blood lactate concentrations, related to each step of

Table 1. Mean (± standard deviation) physiological variables obtained during standardized exercise tests in 10 mid-level (60–90 km) endurance horses (group A) and 7 high-level (120 km and more) endurance horses (group B)

Test	Group	VLA2 (km/h)	VLA4 (km/h)	V160 (km/h)	V200 (km/h)	HR2 (bpm)	HR4 (bpm)
Field	A	18.8 ± 4.66	26.9 ± 6.29[b]	24.3 ± 3.70[a]	34.7 ± 4.82[b]	142 ± 15.9	172 ± 13.7
	B	22.4 ± 3.66	34.9 ± 2.62	30.3 ± 3.54	42.8 ± 3.15	138 ± 6.25	176 ± 15.6
Treadmill	A	21.2 ± 4.50[a]	26.5 ± 4.50[b]	20.5 ± 5.83	33.5 ± 3.41[a]	158 ± 17.5	185 ± 18.8
	B	26.6 ± 2.74	34.2 ± 3.08	25.0 ± 2.61	38.8 ± 3.97	165 ± 11.8	191 ± 7.24

[a] Significantly different from corresponding value in group B with $P < 0.05$.
[b] Significantly different from corresponding value in group B with $P < 0.01$.

both tests, are presented in Figure 1. During the FT, the HRs and the blood lactate concentrations were significantly lower in group B throughout all steps, but only significantly lower in group B during steps 1 and 3 of the TT. The HRs measured at walk during recovery 2, 5, and 10 min after FT or TT were not significantly different between groups.

Values for the variables of the exercise tests are presented in Table 1. There was a significant difference between groups, during both FT and TT, for VLA4 and V200, and during TT for VLA2, with higher values for group B. There was no significant difference between groups for V160 during TT, but V160 was significantly higher in group B during FT. HR2 and HR4 were not different between groups, but were significantly higher during TT than during FT.

The aims of this study were to examine the ability of a FT, corresponding to the requirements of endurance horses' owners, to discriminate between horses from different racing levels, and to compare the results with those obtained with a TT. The field test was completed by each horse without any problems. It was well-accepted by the riders and was able to discriminate 2 groups of horses from different racing levels according to fitness parameters such as V160, V200, and VLA4.

The first step in the FT was designed to mimic mean speeds usually run on the flat by endurance horses during their race and to be long enough (27 km) to correspond to the mean distance usually run by horses during races between vet checks and imposed rest. The TT design (3 steps of 3 min with 2 min rest between steps and an incline of 4%) was adapted from previously reported tests (4,6–8).

The aim of the last step in both tests was to reach a lactatemia greater than 4 mmol/L to obtain a value for VLA4, and to reach HRs as close to 200 bpm as possible, in accordance with Persson (9). Most of the horses from group B did not reach a lactatemia of 4 mmol/L or a HR of 200 bpm during FT. Heart rate response to exercise of increasing intensity is linear between 120 and 210 bpm (10), but the calculations of VLA2 and VLA4 are based on the design of an exponential curve that has a shallow slope at lower speeds. Because of this, the velocity that elicits a lactatemia of 2 mmol/L or 4 mmol/L (especially when the threshold of 4 mmol/L was not reached) may vary. Ideally we should have added a step at a higher speed in order to obtain VLA4 in all horses, but due to the required owners'/riders' consent this was not possible.

V200 is a variable of choice for the assessment of exercise tolerance or fitness in the horse (11). In our study, an increase in V200 was noted with the levels of performance in both tests, which is in accordance with previous studies on exercise testing in the field or on the treadmill (3,11,12), although sometimes controversial (13). However, V160 was better in group B during FT but not during TT which could be explained by the influence of apprehension and anxiety on HR at lower HRs. This stress could also be seen in the fact that HR2 and HR4 during TT were significantly higher than during FT although VLA2 and VLA4 were not significantly different between the SETs.

Blood lactate concentrations measured during each SET were lower for group B compared with group A, and VLA4, another gold standard for fitness and performance assessment (13), was significantly higher for group B in both SETs. Other useful measurements are HR2 and HR4, providing the rider with important information regarding the intensity of the training session. Indeed working close to VLA2 was shown to increase VLA4 in horses over a period of 6 wk (14). So, for an exercise, basing the work on HR2 could increase endurance capacity, if the HR2 is regularly recalculated.

Measurements obtained in field conditions have been suggested to be less reliable than those obtained in treadmill tests for physiological evaluation. However, in the present study we showed that FT could provide useful physiological parameters (such as VLA4, V200, and even V160) if the test is well-conducted and well-standardized, agreeing with previous studies (1,15,16). Field investigations allow the tests to be conducted in an environment likely to be used at training and in competition. The surfaces, gaits, and speeds in a field test are more closely aligned to the demands that horses face during exercise in "genuine conditions." Field tests also account for the effect of the rider and may be performed without access to sophisticated equipment (2).

The main advantage of using treadmill versus field tests to evaluate fitness and health of horses is the ease of standardization (physical environment, speeds, and durations of each step). But horses should be acclimated to the treadmill before testing (17), especially when fitness has to be evaluated. Development of suitable and reliable field tests, which can be incorporated into the daily routine of commercial training establishments, could increase the accessibility of applied exercise physiology by reducing dependence on treadmill testing. Exercise tests should be easy to implement, acceptable for the trainers and riders, and ideally should not disrupt normal training schedules. The design of our FT was based on these criteria.

In conclusion, the field exercise test proposed in this study has the advantage that it is easily undertaken with little equipment. It was well-accepted by the riders and horses and can be integrated into the training program as a usual gallop session. The FT gives the riders useful information about their horses' fitness status, such as VLA4, V160, and V200, and it can discriminate horses of different race levels. In addition, this test can be repeated regularly along with a medical follow-up examination in order to detect early physiological abnormalities.

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